

CLAIMS:

1. A lithographic projection apparatus comprising:
 - an illuminator configured to provide a projection beam of radiation;
 - a support structure configured to hold a patterning device, the patterning device configured to pattern the projection beam according to a desired pattern;
 - a substrate table configured to hold a substrate;
 - a projection system configured to project the patterned beam onto a target portion of the substrate; and
 - a measurement system comprising:
 - a diffractive element and a structure configured to increase the pupil filling of the radiation in the pupil of the projection system, both movable into the projection beam between a radiation system and the projection system, and
 - a sensor module configured to sense radiation that has traversed the projection system to measure wave front aberrations of the projection system.
2. A lithographic projection apparatus according to claim 1, wherein said sensor module is configured to measure wave front aberrations of the projection system.
3. A lithographic projection apparatus according to claim 1, wherein the structure configured to increase the pupil filling comprises a structure configured to diffuse the radiation.
4. A lithographic projection apparatus according to claim 3, wherein a single member has the function of both the diffractive element and the structure configured to diffuse the radiation.
5. A lithographic projection apparatus according to claim 3, wherein the diffractive element comprises a reflective grating in which the reflective portions comprise the structure configured to diffuse the radiation.

6. A lithographic projection apparatus according to claim 3, wherein the structure configured to diffuse the radiation comprises an array of reflective portions randomly staggered in height.
7. A lithographic projection apparatus according to claim 6, wherein each reflective portion comprises a multilayer structure.
8. A lithographic projection apparatus according to claim 3, wherein the structure configured to diffuse the radiation comprises sub-resolution absorptive features.
9. A lithographic projection apparatus according to claim 3, wherein the diffractive element comprises a transmissive grating, and the measurement system further comprises a mirror configured to direct the projection beam to illuminate the grating from behind, wherein the structure configured to diffuse the radiation comprises imperfections in the mirror.
10. A lithographic projection apparatus according to claim 9, wherein said mirror is curved to provide a focusing effect.
11. A lithographic projection apparatus according to claim 1, wherein the diffractive element comprises a transmissive grating, and the measurement system further comprises a mirror configured to direct the projection beam to illuminate the grating from behind, wherein the mirror is curved to provide a focusing effect and comprises the structure configured to increase the pupil filling of the radiation in the pupil of the projection system.
12. A lithographic projection apparatus according to claim 9, wherein, in use, the mirror is tilted at an angle relative to the plane of the grating to provide a tilted illumination beam.
13. A lithographic projection apparatus according to claim 11, wherein, in use, the mirror is tilted at an angle relative to the plane of the grating to provide a tilted illumination beam.
14. A lithographic projection apparatus according to claim 1, further comprising at least

one Fresnel amplitude zone plate movable into the projection beam configured to focus the beam that reaches the diffractive element.

15. A lithographic projection apparatus according to claim 1, wherein the structure configured to increase the pupil filling is configured such that the radiation of the measurement system at least substantially fills the pupil of the projection system.

16. A lithographic projection apparatus according to claim 1, wherein the sensor module comprises a further diffractive element, such as a grating, and a radiation sensor, such as a CCD.

17. A lithographic projection apparatus according to claim 1, wherein said projection beam of radiation comprises EUV radiation.

18. A measurement system to measure wave front aberrations of a projection system, said measurement system comprising:

a diffractive element and a structure configured to increase pupil filling of radiation in a pupil of the projection system, both movable into a projection beam between a radiation system and the projection system; and

a sensor module configured to sense radiation that has traversed the projection system to measure wave front aberrations of the projection system.

19. A measurement system according to claim 18, wherein the structure configured to increase the pupil filling comprises a structure configured to diffuse the radiation.

20. A measurement system according to claim 19, wherein the diffractive element comprises a reflective grating in which the reflective portions comprise the structure configured to diffuse the radiation.

21. A measurement system according to claim 19, wherein the structure configured to diffuse the radiation comprises an array of reflective portions randomly staggered in height.

22. A measurement system according to claim 19, wherein the structure configured to diffuse the radiation comprises sub-resolution absorptive features.

23. A measurement system according to claim 19, wherein the diffractive element comprises a transmissive grating, and the measurement system further comprises a mirror configured to direct the projection beam to illuminate the grating from behind, wherein the structure configured to diffuse the radiation comprises imperfections in the mirror.

24. A measurement system according to claim 18, wherein the diffractive element comprises a transmissive grating, and the measurement system further comprises a mirror configured to direct the projection beam to illuminate the grating from behind, wherein the mirror is curved to provide a focusing effect and comprises the structure configured to increase the pupil filling of the radiation in the pupil of the projection system.

25. A measurement system according to claim 23, wherein, in use, the mirror is tilted at an angle relative to the plane of the grating to provide a tilted illumination beam.

26. A measurement system according to claim 24, wherein, in use, the mirror is tilted at an angle relative to the plane of the grating to provide a tilted illumination beam.

27. A lithographic projection apparatus comprising:

- an illuminator configured to provide a projection beam of radiation;
- a support structure configured to hold a patterning device, the patterning device configured to pattern the projection beam according to a desired pattern;
- a substrate table configured to hold a substrate;
- a projection system configured to project the patterned beam onto a target portion of the substrate; and
- a measurement system configured to measure defocus of the apparatus, comprising a transmissive grating and a mirror configured to direct the projection beam to illuminate the grating from behind, wherein, in use, the mirror is tilted at an angle relative to the plane of the

P-0364.010-US

grating to provide a tilted illumination beam.

28. A lithographic projection apparatus according to claim 27, wherein the mirror is at least one of plane and curved.

29. A lithographic projection apparatus according to claim 27, wherein the mirror is adjustably tiltable by means of an actuator.